



The WZ Group: Status and Plans

Georg Steinbrück
April Collaboration Meeting

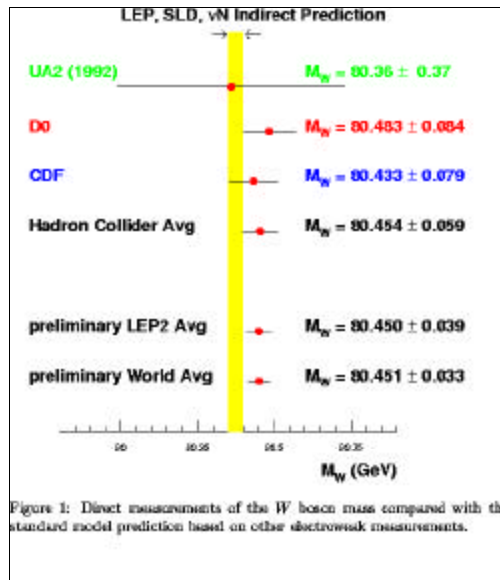


Run 1 Never Dies...

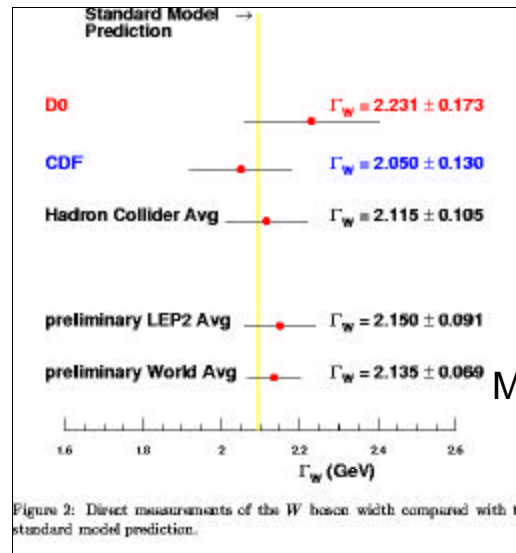
- dir. W Width and Edge W Mass papers submitted to PRD
- CDF-D0 combination group has been very active combining W mass and width
- Note for collaboration review:

Good exercise for Run II!

<http://www.phy.duke.edu/~kotwal/combine.ps>



G. Steinbrück



Martin Gruenewald

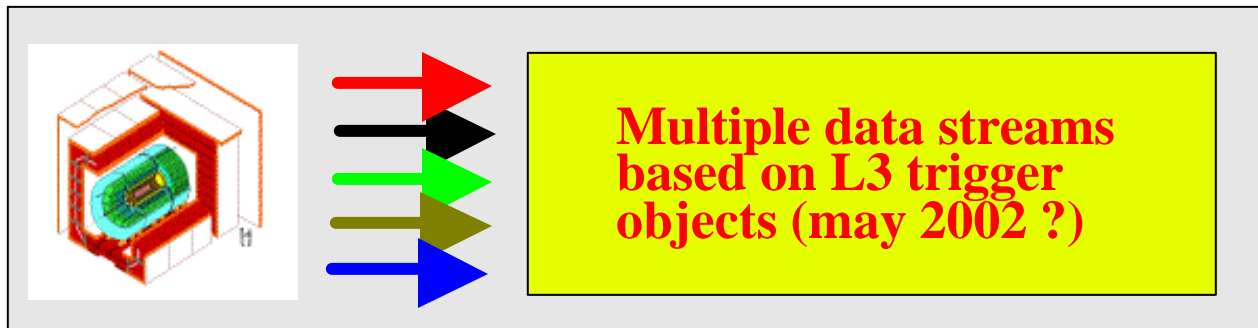
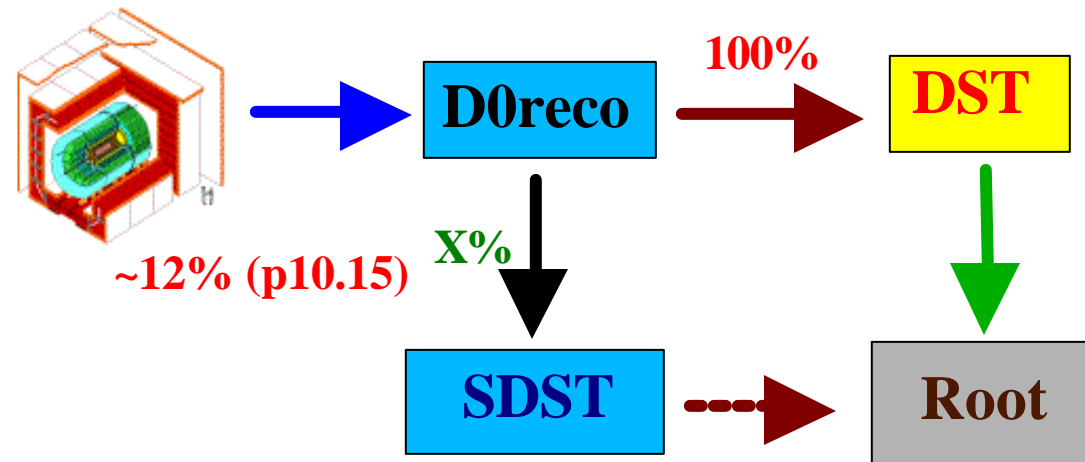
Sarah Eno

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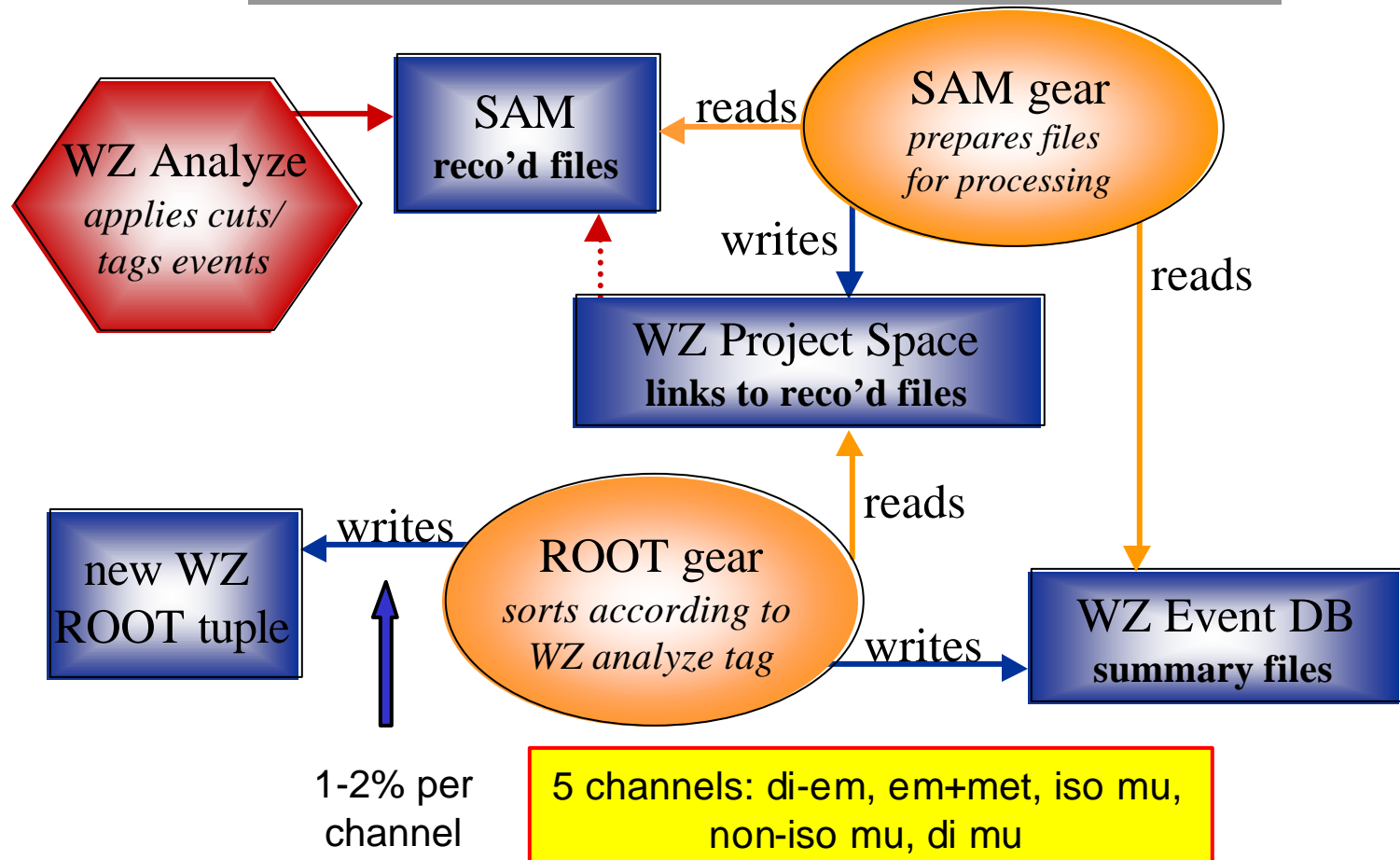
Current Efforts: ID

- Lots of the work is ID based: Informal WZ muon and electron squad meetings rather than physics subgroups
- Contributions to ID groups
 - Tracking (Gavin Hesketh)
 - Scintillator Timing (Andrew Askew)
 - Good Muon Run List (Tom Diehl)
 - EM id (Mingcheng Gao)
 - Tau ID (Silke Duensing)
 - Luminosity (Marco Verzocchi)
- Tools:
 - offline streaming (Marco)
 - la Macchina (Julie Torborg)

Tools: Special Reco Streaming



Tools: La Macchina



Current Efforts: Analyses

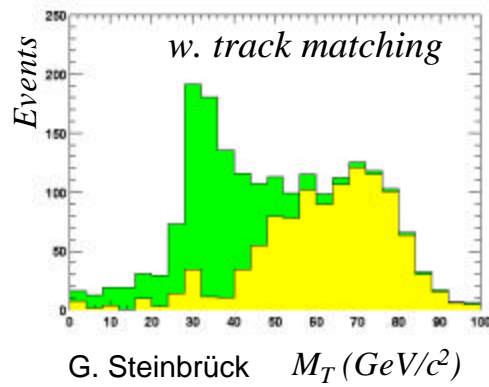
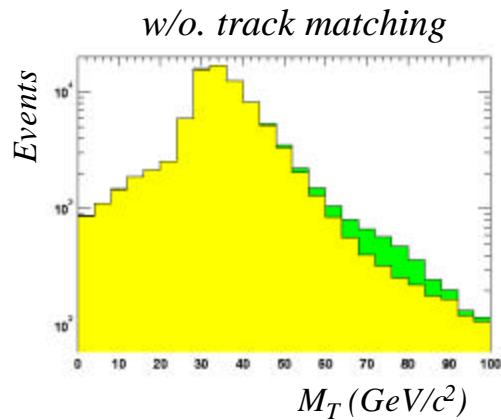
- Current analyses based on student's interests
 - W and Z cross sections in electrons and muons
 - W gamma analysis and radiation zero
 - W charge asymmetry
 - Z' search
 - Z- \rightarrow tau tau
 - (Z- \rightarrow bbar)
- 4 APS talks (Run II) + 1 Madison talk (Run 1)
- 3 DPF talks (2 Run 1)

Monte Carlo

- So far: pythia + full geant
- Will make extensive use of fast Monte Carlo (pmcs)
 - Under way.
 - Interfaced with the Run 1 W mass generator (CMS)
 - Pythia interface with Baur diboson generator under way
- Manchester group is comparing Herwig to Run 1 W and Z pT data: Emily Nurse with Mike Seymore

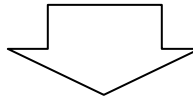
W event sample

Track matching necessary to disentangle overwhelming QCD background



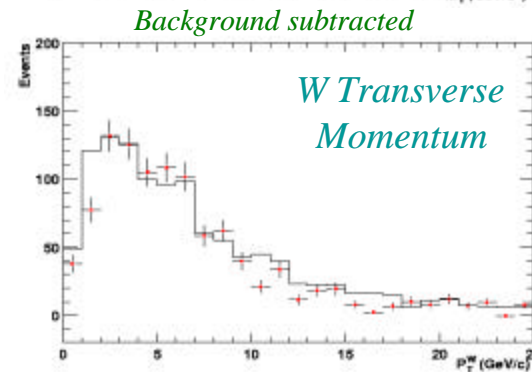
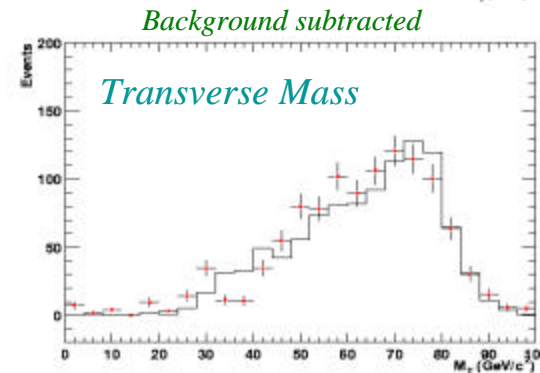
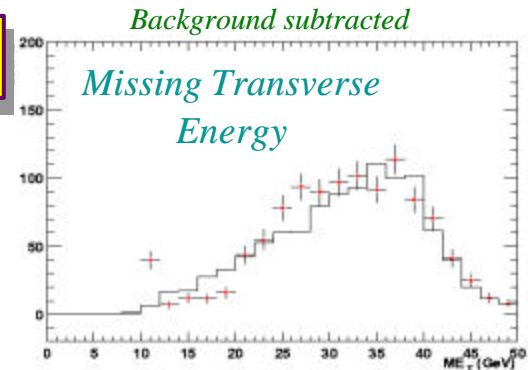
Remaining background due to fake electrons: fake probability from Compton QCD events

Matching efficiency from Z events



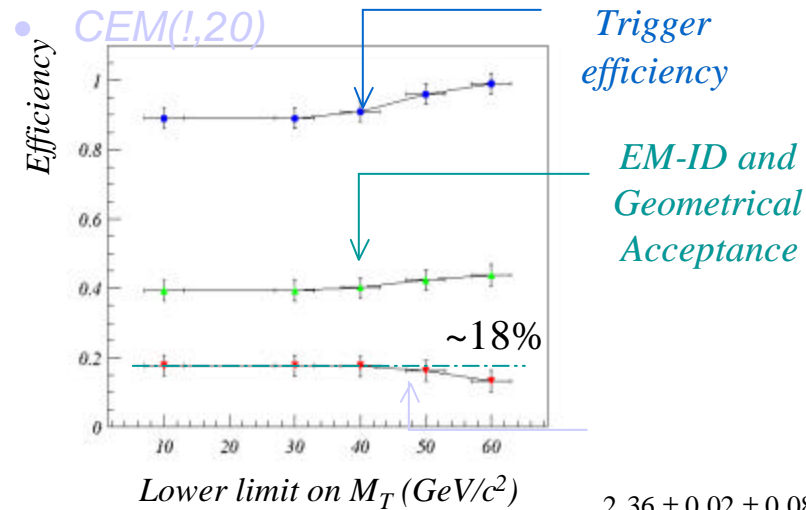
Evaluate background and signal contributions using matrix method

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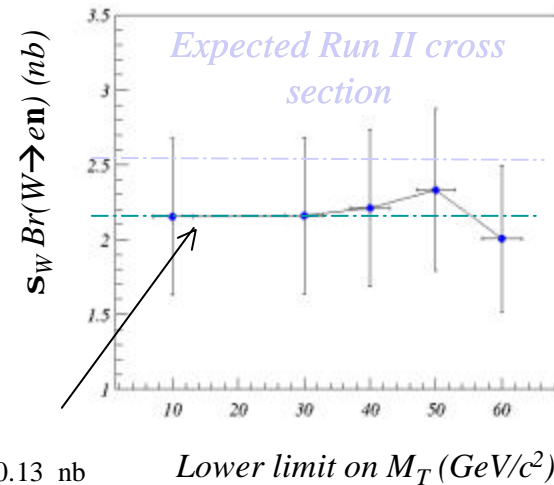


Cross section measurement

Using the “Moriond” data sample only



$$s_W \times \text{Br}(W \rightarrow eu) \equiv \frac{n_{\text{obs}}}{L \times e^{\text{trig}} \times e^{\text{geo}} \times e^{\text{sel}} \times e^{\text{EM}}}$$



$2.36 \pm 0.02 \pm 0.08 \pm 0.13$ nb

D0 Phys. Rev. D60 (Vol. 5) 1999

• Efficiency:

$$e = e^{\text{trig}} \times e^{\text{geo}} \times e^{\text{sel}} \times e^{\text{EM}}$$

$$L \approx 0.83 \pm 0.08 \text{ pb}^{-1} \approx 15 - 20\%$$

(Normalized to min. bias)

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Good agreement with the expected cross section

Marumi Kado

Robert Ziton 9

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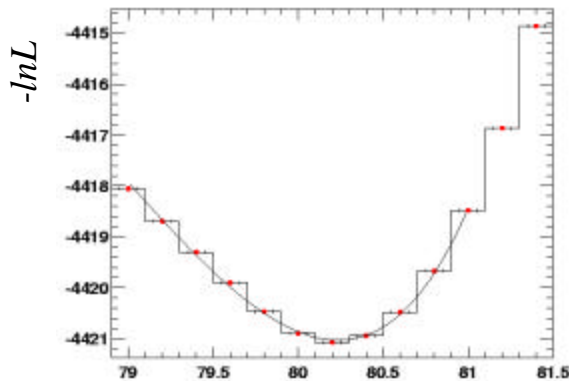
Towards a W Mass Measurement

Using the full data sample and a relativistic
Breit-Wigner re-weighting method for the
Monte Carlo

$$\ln L = -\mathbf{I} \times s_i(m_W) + n_i \ln(\mathbf{I} \times s_i(m_W) + b_i)$$

$$\frac{\partial \ln L(m_W, \mathbf{I})}{\partial \mathbf{I}} = 0$$

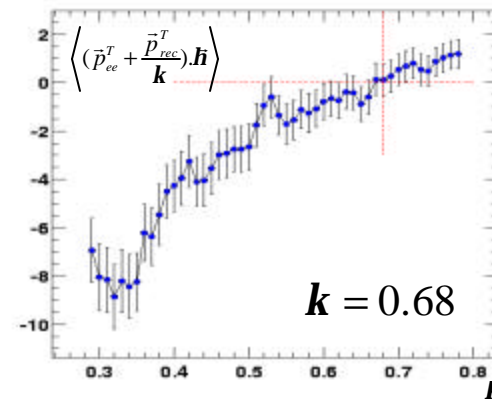
- Signal normalization \mathbf{I}
parameter of the fit
- Background obtained from
the data (matrix method)



$$m_W = 80.2 \pm 0.4 \text{ GeV}/c^2$$

Corrections:

- NLC
- Pulser calibration
- Refined calibration with Z events
- Unclustered energy scale:

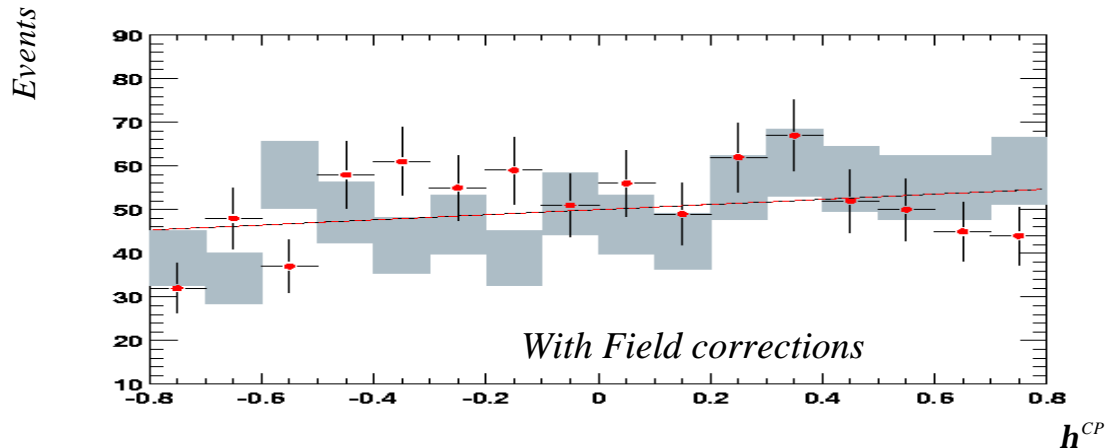


With all corrections taken into account

$$m_W = 81.7 \pm 0.4 \text{ GeV}/c^2$$

Rapidity Distributions

- Towards a charge asymmetry, a glance at the rapidity distribution...



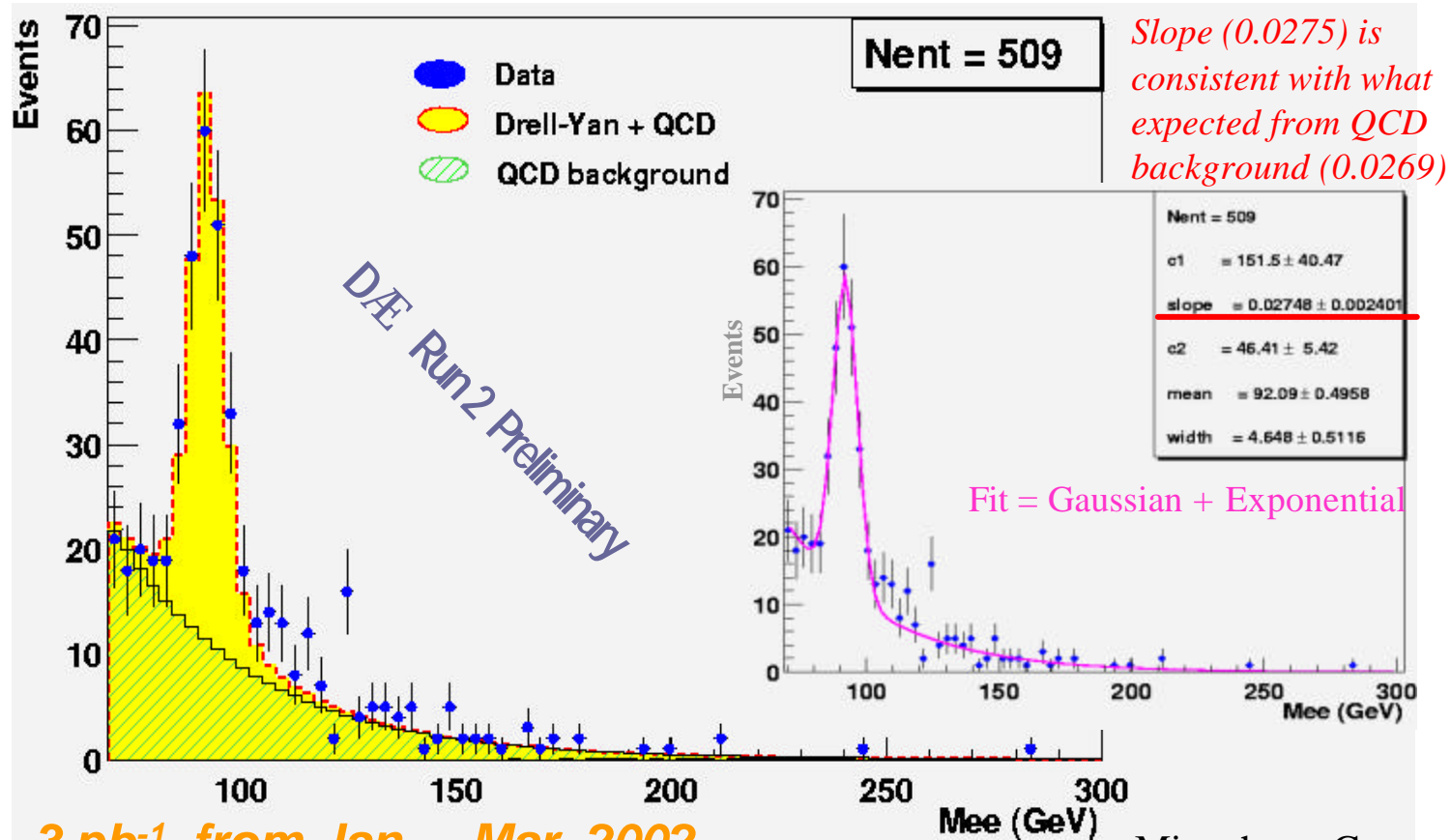
$$h^{CP} \begin{cases} h & \text{for electrons} \\ -h & \text{for positrons} \end{cases}$$

*Increase statistics assuming CP
symmetry
look at*

*Mild h dependence, due to competition between production and
decay asymmetry*

More data and a larger rapidity acceptance is needed...

Z Cross Section + Z' Search



Z' Search: Including Track Match

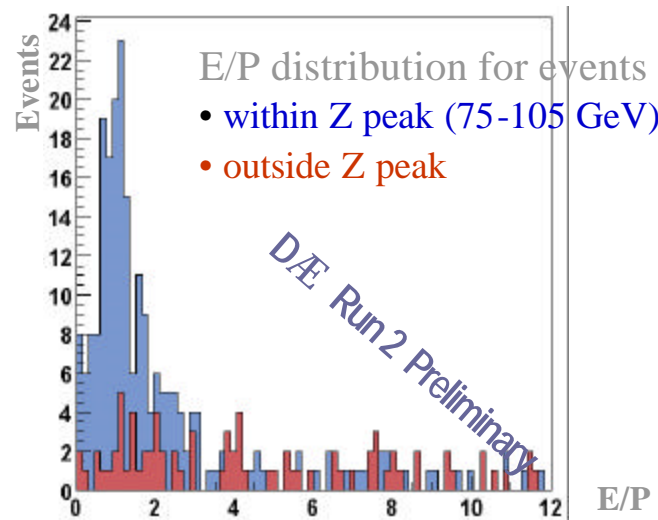
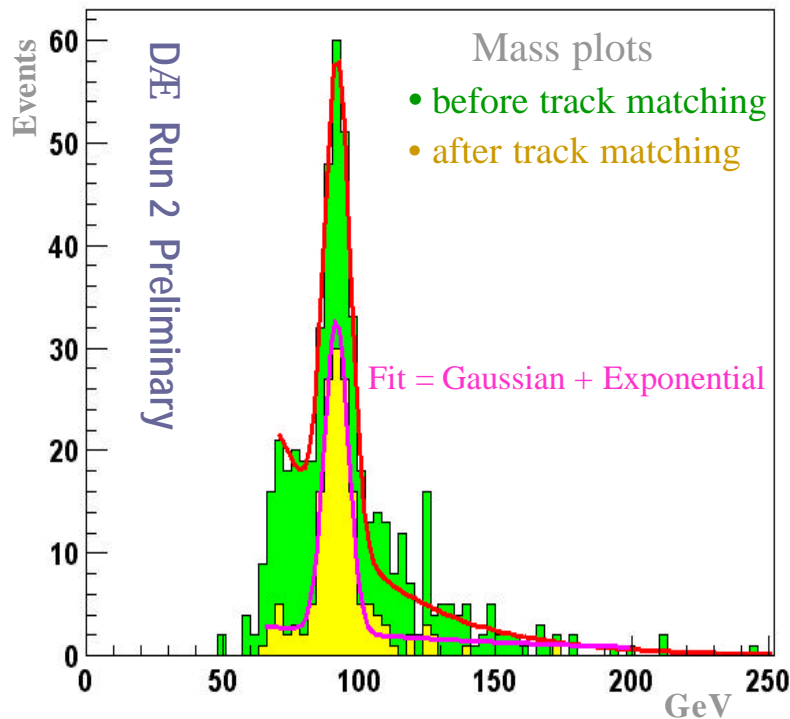
Matched track:

- $|\phi_{\text{electron}} - \phi_{\text{track}}| < 0.02$
- Close to vertex (< 1 mm)
- $|E/P| < 2$

Track matching efficiency:

- Z/γ^* events $\sim 70\%$
- QCD background $\sim 8\%$

=> Track matching can significantly reduce fake background, and it's still improving !



Z->ee Cross Section*BR

(without/ with track match)

$s = 246 \text{ pb} \pm 18\% \text{ (stat. only)}$

$s = 263 \text{ pb} \pm 22\% \text{ (stat. only)}$

Matching Central Tracks to Muons

Motivation: muon system momentum resolution.

Method: Extrapolate central tracks to muon system.



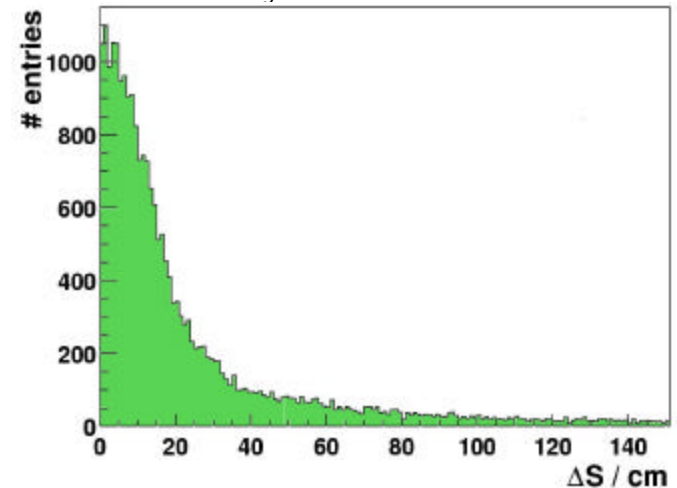
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Look at position residuals:

$$\Delta S(\mu, track) = \sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}$$

at the muon system

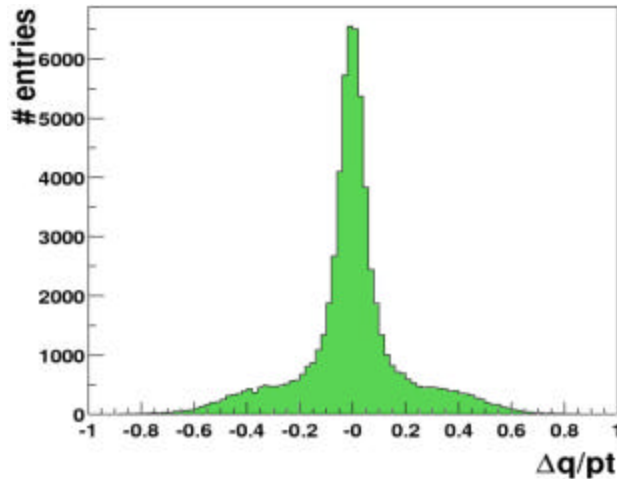


Requiring a loose momentum match

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Matching Central Tracks to Muons



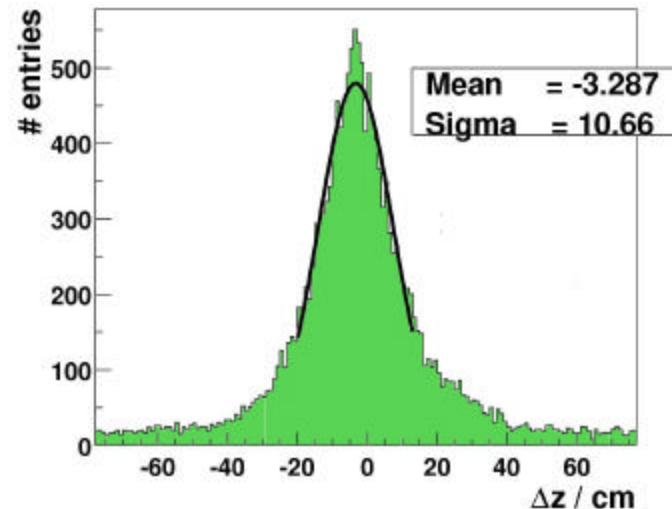
Also, looking at every track near a muon, take the q/pT residual:

$$\Delta \frac{q}{p_T}(\mu, track) = \frac{q}{p_T}(\mu) - \frac{q}{p_T}(track)$$

Looking at:

$$\Delta z(\mu, track) = z(track) - z(\mu)$$

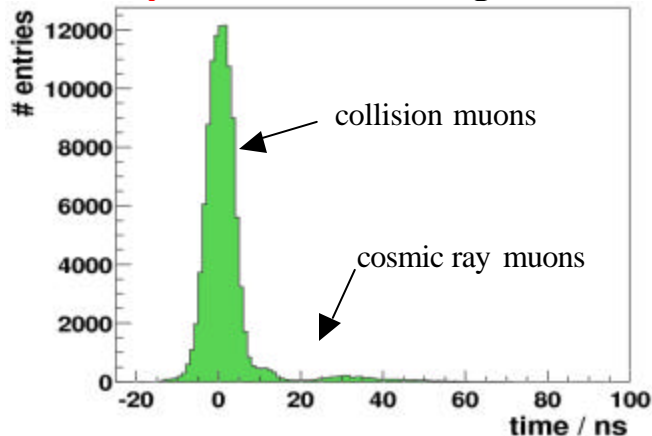
we were able to correct a 3 cm shift in the alignment of the muon system and the central tracker.



Backgrounds to $W/Z \rightarrow \mu$

- 2 main sources - **cosmic ray muons**
- **muons from the decay of heavy quarks**

Cosmic Rays - use the timing of the muon system hits to reject.



Collision muons centered at zero

Cosmic ray muons can come at any time

Muons from heavy quark decays - use isolation parameters

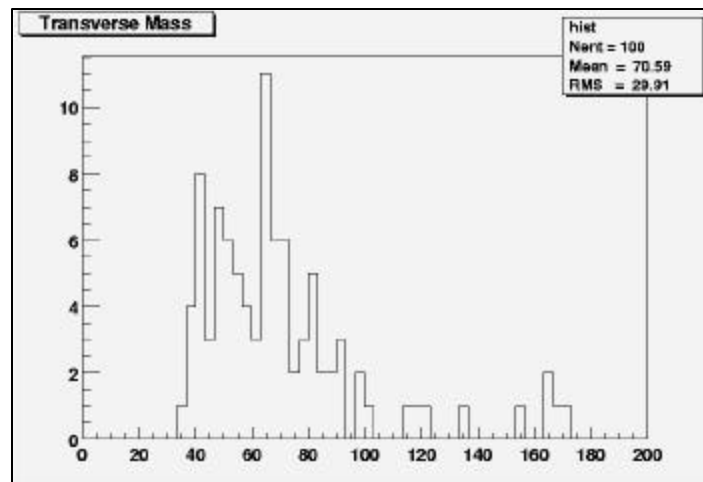
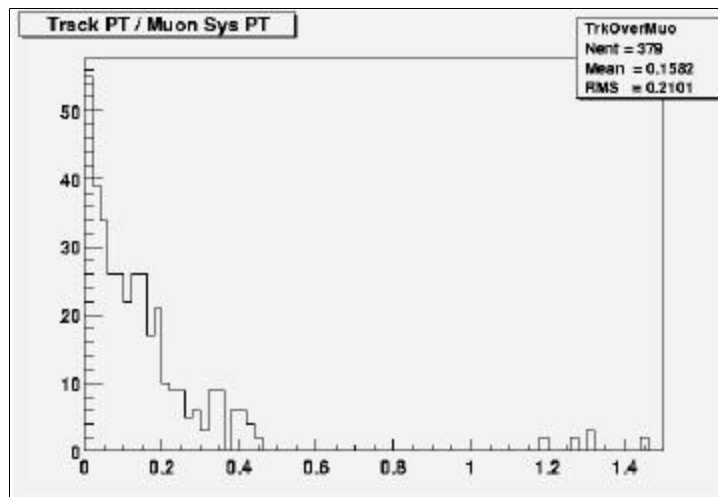
Simple definition: $\Delta R(\mu, jet) = \sqrt{\Delta\phi^2 + \Delta\eta^2}$

Also, look for unreconstructed jets in the calorimeter

W → $\mu\nu$ Search

- Matching SMT → CFT tracks (333) to muons.
- $pT(\text{tracker})/pT(\text{muon})$:
 - $pT_m > 20 \text{ GeV}$

Recalculate MET
using $pT(\text{track})$
instead of pT
muon.

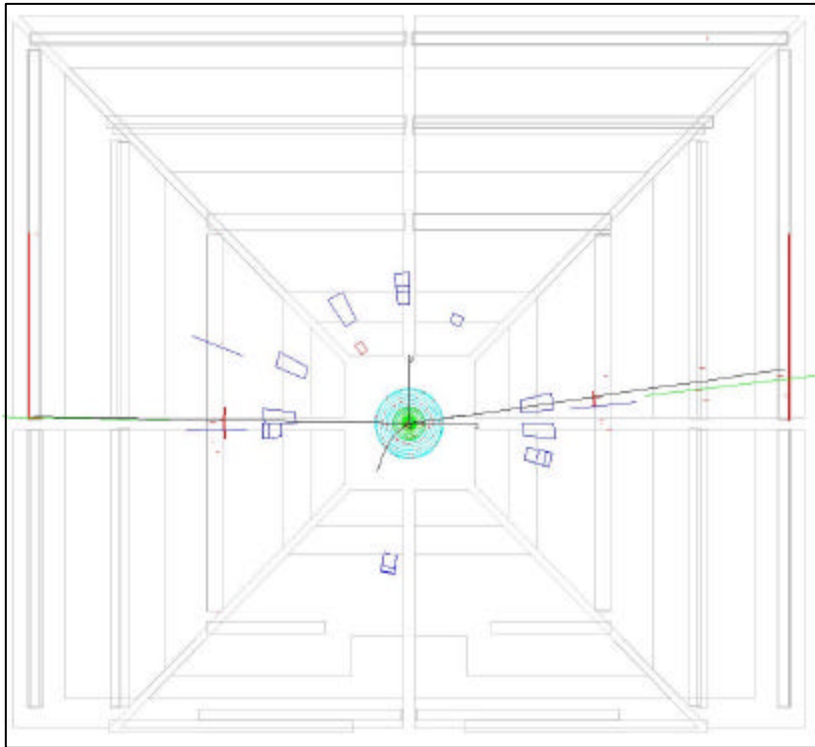


First hint of a signal,

mT (GeV)

Need background calculation!

Z- \rightarrow mm candidate



2 muons with matched
central tracks

mass = 102.7 GeV

Gavin Hesketh 20 April 2002

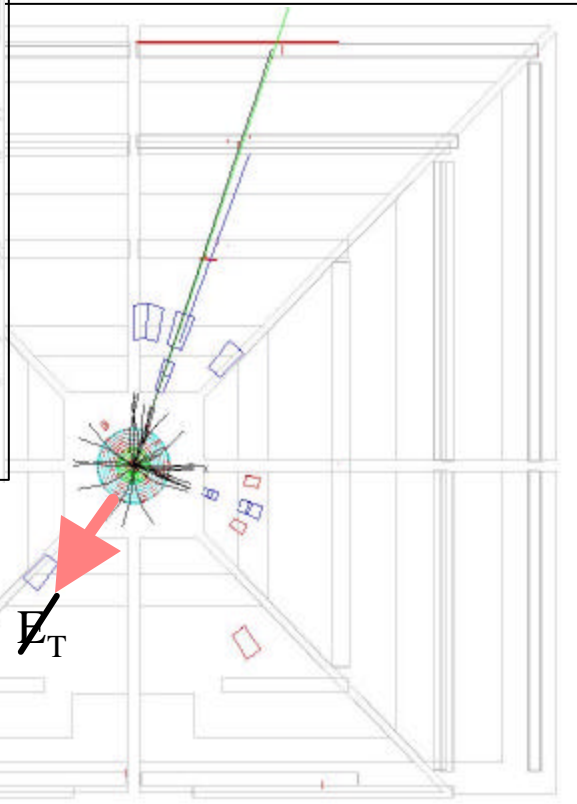
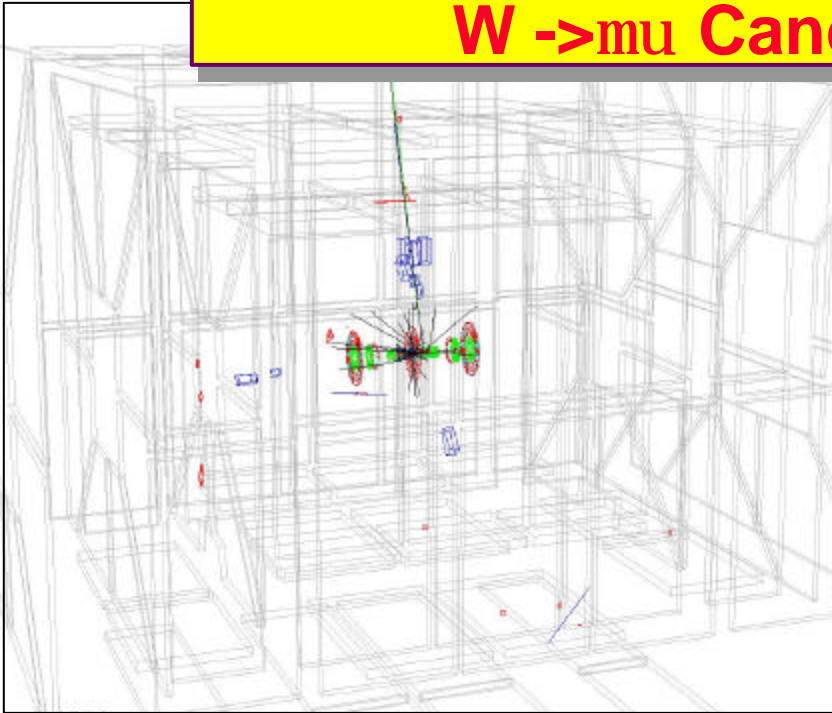
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W \rightarrow μ Candidate

Central track matched to muon
Transverse Mass = 78 GeV

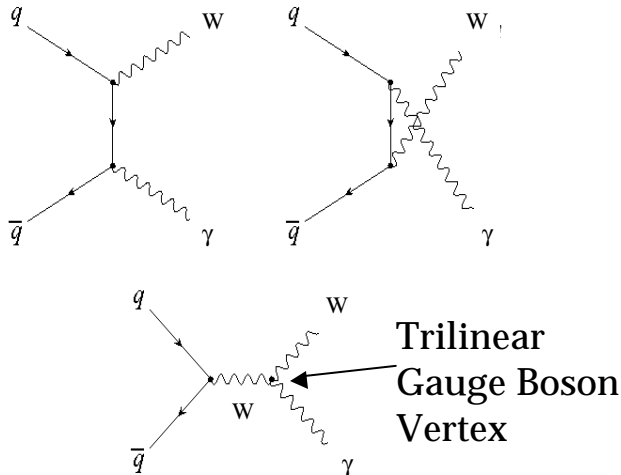


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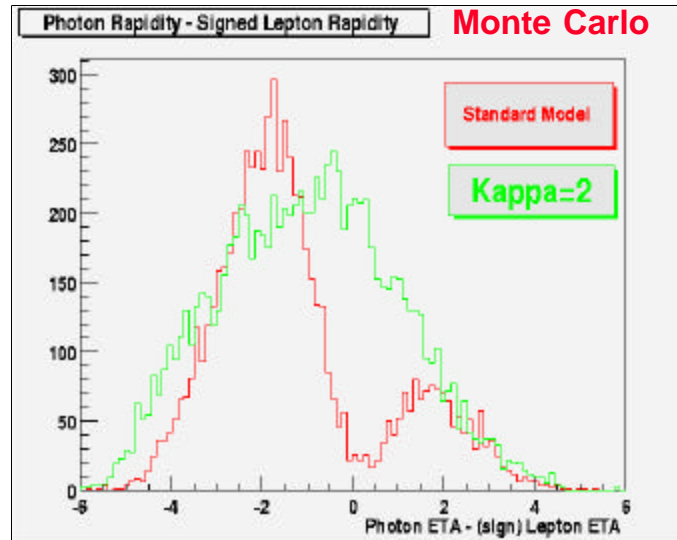
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Wg + Radiation Zero

- Standard model makes predicts WWg coupling. Cross sections enhanced by anomalous couplings.
- Looking at $W \rightarrow \mu\mu$ and $W \rightarrow e\nu$.

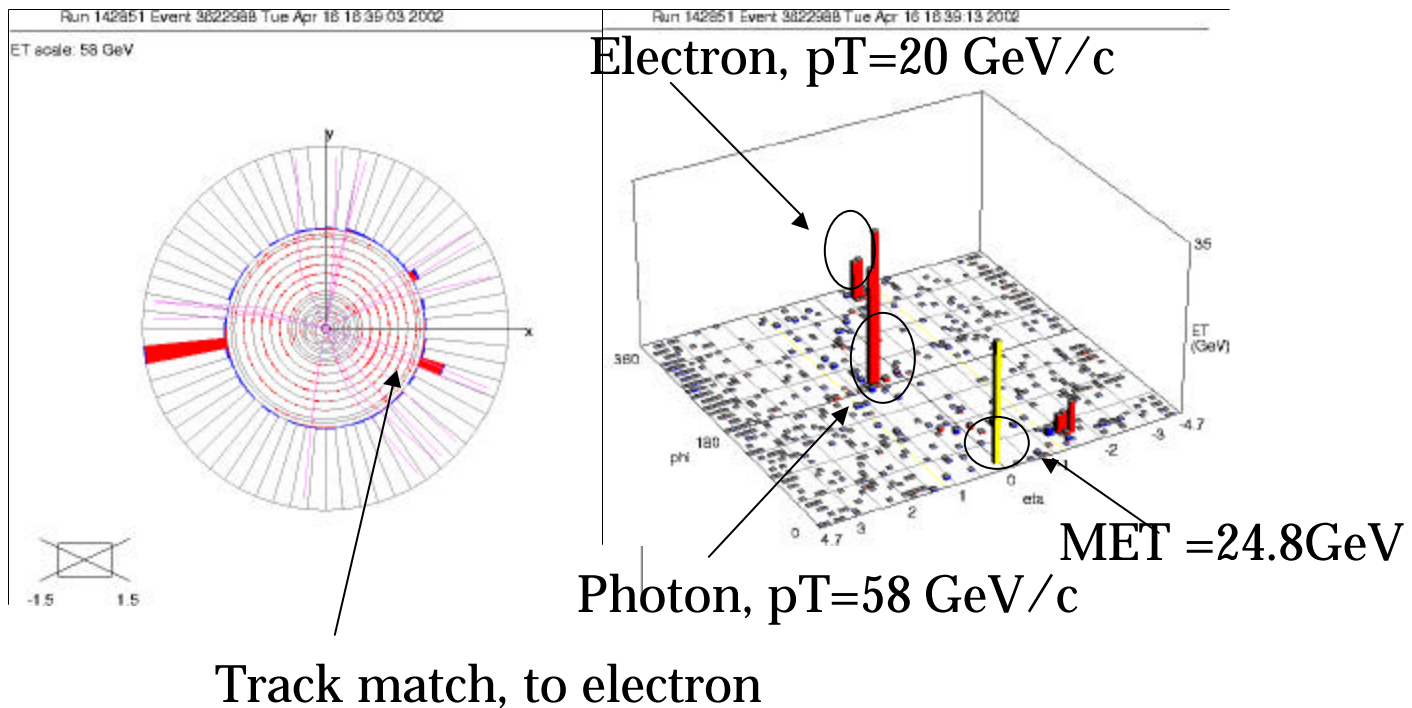


Standard Model diagrams for W+photon Production

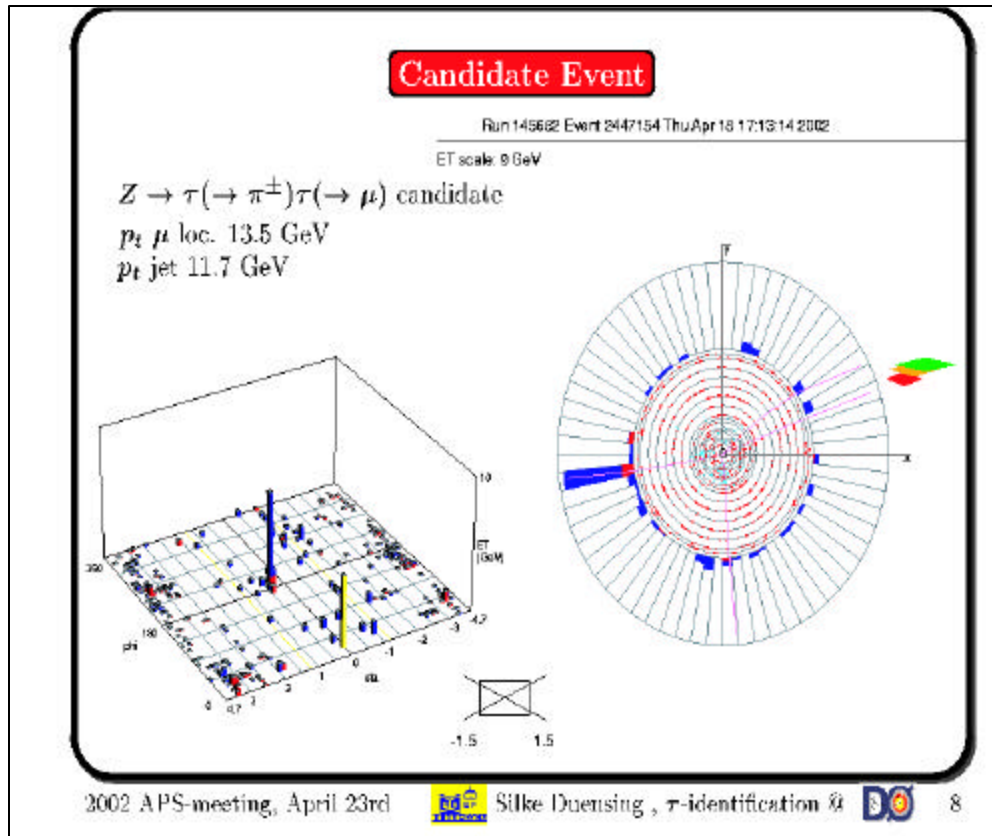


- The three Standard Model diagrams interfere
- The interference between these diagrams causes an angular zero in the spin and color averaged matrix element.
- If anomalous couplings exist, this angular zero is filled in.
- Never before observed. Andrew Askew

A first candidate?



Z->tt candidate



Jets are too narrow->QCD jets look like tau jets

A Common Thread

- non-linearities and/or
- high thresholds in zero suppression of low Energy calorimeter cells lead to

→

- 1) Jets are too narrow (taus!)
- 2) Jets fall under 8 GeV Threshold that would otherwise be reconstructed → Background from b jets to $W \rightarrow \mu\mu$ is higher than in Run 1 by a factor of 10
- 3) Unclustered energy scale low. MET imbalance in jet+g events → Improves with non-linearity corrections!
will be p11!

Plans for the Summer Conferences

- **Improvements in Reco p11**
 - Alignment, Improved muon global fit, tight and loose muons
 - L3 muons
 - better tracks
 - non linearity corrections
 - ...
- **Expect:**
 - **W and Z cross sections in electrons**
(not so much as a physics result but rather as proof that we understand the whole chain detector-trigger-reconstruction)
 - **similarly: Z' analysis**
 - **W and Z signal in muons**

... and beyond (Goals for the rest of the year)

- Tracks, Tracks, Tracks
- Goal: Get to “Physics capable” state as soon as possible:
 - Point in time when we have publication quality data
→ first “physics results”
- Understand taus
- use of $W \rightarrow e\bar{\nu}$ and $W \rightarrow \mu\bar{\nu}$ as monitoring tools in the control room
- **W mass effort is getting started**
- **One of the most important, interesting and challenging measurements at the Tevatron**
- **Goal: 30-40 MeV / experiment → Let’s beat LEP!**
- **Need a strong group of committed people.**
 - **Interested? Talk to us!**

Conclusions

- WZ group has been very active analyzing and understanding current data
- Close contact to ID groups
- Lots of effort has gone into understanding Muons
 - Need tracks for W and Z signals: CTT for unprescaled muon triggers and offline tracks for good momentum resolution
 - L2 and L3 muon triggers coming online!
- Electrons: Lots of effort understanding tracks
- Expect large improvements both in jets and unclustered energy from non-linearity corrections
- A number of analyses under way, more to come ...
- W mass effort is getting started. Interested parties please contact us!